Remarks

In the Official Action mailed September 27, 2003 restriction was required between the invention of claims 1-8 and 22-25 and that of claims 9-21. In a response dated October 1, 2003 Applicant elected with traverse the invention of claims 9-21 for further prosecution. In an Official Action dated April 9, 2004, it was indicated that claims 1-8 and 22-22 were withdrawn from further consideration and claims 9-21 were rejected under the judicially created doctrine of double patenting over claims 7-15 of U.S. Patent No. 6,232,354. No other basis for rejection was presented in this Official Action. In response, Applicant filed a Terminal Disclaimer that was mailed on April 16, 2004 (copy enclosed). The Examiner now comes forward with: 1) an indication that the previous restriction requirement is made final (it was Applicant's assumption that this was already the case based on the earlier Official Action); 2) a rejection of claims 9-21 based upon Double Patenting, as previously presented in the Action of April 9, 2004 and met with the previously filed Terminal Disclaimer; and 3) adds a further grounds for rejection under 35 U.S.C. 103(a) based on obviousness over WO 92/17533 taken with Keiser. It is respectfully submitted that claims 1-8 and 22-25 have been previously withdrawn and that the earlier filed Terminal Disclaimer overcame the Double Patenting rejection.

Given the foregoing facts, Applicant hereby withdraws claims 1-8 and 22-25 from further consideration and respectfully submits that the previously submitted Terminal Disclaimer overcomes the Double Patenting rejection.

Addressing now the last newly presented grounds for rejection, that concerning obviousness over the teachings of WO 92/1753 taken with Keiser, it is the Examiner's position that patentees disclose the making of nanocomposite or molecular composite polymer by <u>extruding and foaming</u> with a carbon dioxide blowing agent at temperatures and pressures used in the instant case. As currently drafted and submitted herewith, broad claim 9 clearly requires that, as a first step, the polymer to be foamed be consolidated by compression molding. As is well recognized in the art, extrusion apparatus cannot achieve the pressures and hence the consolidation obtained in the compression molding process. (See specifiacally page 6, line 21 to page 7, line 2) Since as set forth in the instant application, compression pressure is a function of the make up of the polymer as well as the temperature at which compression/consolidation is performed, no specific compression pressure is specified, compression molding is the process to be used to obtain adequate consolidation for the performance of the steps that follow and to obtain the products described and claimed.

Additionally, it is pointed out that a major thrust of the present invention is the applicability of a process described generically in the 6,232,354 patent to the production of nanocomposite or molecular composite foams that exhibit exceptional physical properties. The foams of the instant application exhibit cell diameters in the range of from about 1 to about 100 microns. While the cells described in WO 92/17533 are characterized as between 0.1 and 2 microns with some examples of average cell sizes on the order of 5 microns, there is no suggestion in this patent or

Keiser of that applicability of the process to nanocomposite or molecular composite polymers as alluded to by the Examiner. The materials treated in this patent are largely semi-crystalline polymers and the like.

The technique of the present invention can produce foams of any thickness with the indicated cell sizes. The use of a higher pressure, over 3000 psi, results in better molecular alignment and consolidation of the wall of the foam. The pressure inside our vessel is controllable to a very stable state whereas it fluctuates a lot inside an extruder as used by WO 92/17533 and Keiser. It is a commonly accepted fact that a foam or sheet fabricated by an extruder results in a material with preferential directional properties and larger (broader) pore size distribution. Foams created by the technique of the present invention have isotropic or near isotropic properties and narrower pore size distributions. This creates the excellent structural properties that WO 92/17533 and Keiser cannot achieve. Foams produced by the method of the present invention have equivalent or better mechanical properties than their parent materials. This is a major accomplishment! Foams created by techniques using lower pressure, like aerogels, have even smaller cell sizes, as small as nanometers, but have poor mechanical properties. Mechanical properties rely on molecular alignment and consolidation of the ligament of the foam, which has found to near perfection with the technique and conditions described and claimed in the instant application.

Patent WO 92/17533 "Supermicrocellular Foamed Materials" is basically the same as patent 5,158,986 by Cha, Suh, Baldwin, and Park that presents a microcellular foaming technique using a supercritical fluid. This patent addresses fabrication by extruder, injection molding, and batch-process. All the examples shown are samples made by the batch-process and <u>very thin samples, 1/16 inches</u>. Their batch-process is a two-step process, which includes (1) saturating the polymer sheet with a gas at around room temperature, and (2) taking the sample out and dipping it in a glycerin oil bath heated to near the Tg of the polymer. Major differences between this patent and the technique of the present invention are: (the following discussion addresses both extrusion and batch processes)

(1)<u>Process Steps.</u> The instant invention is a one step process whereas their batch process is a two-step process. In the instant invention, raw material is placed inside a pressure vessel, heat and pressure are applied, followed by cooling down to a temperature below Tg of the material while maintaining the pressure or partially releasing the pressure. The supermicrocellular foams are completely processed in one–step.

(2) <u>Only thin materials can be processed.</u> The prior art patented technique is limited to very thin material, e.g. 1/16-in as shown in all of the examples. In the case of the extrusion process, the reason is that they have to quench the foam rapidly in order to lock in the pore size. This can only be accomplished in a thin sheet structure since rapid quenching is not possible in a thicker structure simply because of the heat transfer properties of the foam. For thick sheets, the interior part will not be cooled down quick enough to control the pore size. In the case of the

prior art batch process, the reason for treating only thin sheets is that they have to heat the saturated polymer in a glycerin bath during the second step for the saturated fluid inside the material to expand. The dipping time thus needs to be as short as a few second in order to get a very small bubble size. It is impossible for the heat to reach the interior part of a thick sample within a few seconds. If the sample were heated for a longer period of time, the bubbles at the exterior portion of the foam would be very large while those t the center of the structure would be relatively small. The bubbles would collapse if growth were not arrested. In the present invention, the temperature is uniform inside the material even the sample is one foot thick. The bubbles nucleate at elevated temperature under a high pressure and maintain their size while the sample cools down slowly under high pressure. This is a very significant difference between the present invention and the prior art.

(3) <u>Limitation of raw materials</u>. Since the prior art uses a glycerin bath for the second stage of foaming (for their batch process), there is a limit on the raw materials that they can foam. Glycerin boils at about 250°C. Therefore, the materials that they can foam will be limited to those with Tg less than about 250°C. The instant invention has no such limitation. It can be applied to virtually any nanocomposite or molecular composite polymeric material. The glass transition temperature of the raw material can therefore be many times higher than can be produced using glycerin oil.

(4) <u>Form of material</u>. The raw material used for the prior art batch process must start with a material already in a well consolidated form, for example, sheets made by an extruder, injection molding or compression molding. The

present invention can use a material in any form, such as powder, since the technique goes through a material consolidation stage by heating up to the softening or melting temperature.

(5) Processing Time. The batch process of the prior art takes 15 or more hours for fluid saturation (the first step) whereas that of the present invention takes only on the order of 15 minutes (up to 2 hours) depending on the thickness of the part.

Thus what has been described and claimed in the instant application is a structurally strong foam material of virtually any thickness made by a process that differs materially from those produced in the prior art. While the prior art may have succeeded in producing polymeric foams that exhibit small cell sizes in very thin sections, their processes do not and cannot produce the uniform cell size, transparent, structurally sound and relatively very thick materials described and claimed in the instant application through the use of the process described therein. It is only using the process of the instant invention, previously distinguished from those of the prior art, to obtain the materials, previously distinguished from those of the prior art that such materials can be obtained.

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In view of the forgoing amendments and the remarks presented hereinabove, it is respectfully submitted that all claims remaining in the application, claims 9-22, now stand in condition for allowance and the same is respectfully requested at an early date.

Respectfully submitted,

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